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Research Article

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Solid Waste Management in the Leather Sector of Bangladesh

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Abstract Tannery industry is a leading export-oriented sector in Bangladesh. It earns a significant amount of foreign currency which contributes to our national economy. Leather processing units generate a large volume of waste of varying nature. In the past, most of the tanneries of Bangladesh were located at Hazaribagh in Dhaka city. Crude disposal of waste made the surrounding area of Hazaribagh unlivable. To save the environment and the nearby Buriganga River, a megaproject comprising all the treatment units of waste was taken by the Government for building a sustainable industrial estate in Savar. Presently by govt. pressure 101 tanneries of Hazaribagh has been shifted to Savar Tannery Estate and also in operation there. But the fact is that there is only a Central Effluent Treatment Plant (CETP) unit for treating liquid waste now and the huge quantity of solid waste of tannery estate is being remained untreated and dumped here and there which is ultimately polluting the environment. Now the development of a sustainable solid waste management system is a prerequisite for creating sustainable Tannery Estate. An attempt has been made to analyze the present scenario of Savar Tannery Estate and also to find out an appropriate option for solid waste management.

Keywords Primary Sludge, Secondary Sludge, Anaerobic Digestion, Volatile Solid, Biogas Production

1. Introduction

Leather manufacturing processes generate a huge amount (332.2 t/d) of solid wastes varying in composition and quantity at various stages [1], [2]. But in our country improper and unhealthy management of tannery waste is always being a concerning issue in the context of the environment.

In lean season 69.1 tons and in peak season 136.6 tons of solid waste were generated every day by the tanneries in Hazaribagh [1]. At present, the total tannery industry of Hazaribagh has been shifted to Savarestate for the aim of developing an ideal industrial zone. There is a highly sophisticated technology to treat their liquid fraction of waste but the fact is that there is no option to manage solid wastes from leather manufacturing processes. The solid waste generated during the tanning of hides and skins (trimmings, fleshings, shavings, etc.) is simply dumped along the rim of the streets or in an open uninhabited space. The part of the waste which is not collected or utilized eventually dries up or drains off to the nearby Dhaleswari river in the rainy season. Moreover, as a result of the disposal of waste, the soil in Savar has also been receiving the industrial chemicals– undoubtedly becoming quite polluted and losing its fertility. As there is no infrastructure for the treatment of solid waste generated by tanneries until now, the future unhygienic atmosphere will be created in the entire locality by disposing of crude solid wastes.

So, it is high time to think about the technological measures to combat environmental challenges from leather processing activities for saving the leather industry as well as the environment. The solid waste management system of Savar tannery estate requires special attention to reduce environmental degradation. The study has been carried out with the aim of finding the actual scenario of solid waste management of the tannery industry in

Bangladesh so that a sustainable management option can be found out. The outcome of this research will give significant information for the waste management plan of the tannery industry in Bangladesh.

The general objectives of the study were to examine the existing condition of tannery estate in terms of solid waste management and to assess the detail characteristics of tannery solid waste and sludge treatment of Savar tannery estate and finally evaluate some practical knowledge about tannery waste management of Bangladesh.

2. Materials and Methods

Basically, the study is mainly descriptive type and literature-based. To draw the whole picture, the methodology of this research work was divided into two parts. The first part of the study included field visit and questionnaire survey to find out the relevant secondary data and the overall scenario of the study area. In the second part of the study, waste samples were collected and analyzed simultaneously for different properties. The raw materials were characterized by analysis, with Standard Methods [3]. The characteristics of different solid wastes were determined through extensive laboratory analysis. The parameters of different solid wastes like pH, total solids and volatile solids, moisture content, protein content, C:N ratio and COD values were determined through extensive laboratory analysis. The pH of the samples was measured electrometrically with Digital pocket-sized pH meter (HANNA, HI 98107). Two buffer solutions containing pH 4.0 and 7.0 were used to calibrate the digital pH meter. Carbon and Nitrogen contents of the fleshing and domestic sewage were determined by using a C-H-N elemental analyzer. Moisture contents were estimated by gravimetric methods after drying at 105°C. The protein content was estimated from the nitrogen content by multiplying with 6.25 [4]. Calorific value was determined according to IS: 1350 (Part 4)-197 by bomb calorimeter.

3. Results

3.1. Tannery Industry in Bangladesh

The contribution of the leather industrial sector in the past decade was around US$ 250 million per year, accounting for around 30% of the country's export (BFLLFEA). The leather industrial sector of Bangladesh has been almost entirely supported by local raw material resources. Based on UNIDO (United Nations Industrial Development Organization) consultants' detailed interaction with the Hide and Skin Merchants Association in December 2005 as well as with the number of tanners and its own assessment, the weight of raw material processed in Bangladesh annually was estimated at about 85,000 t/year [1]. The peak load during the Qurbani period (75 days) was estimated at 450 t/day and the load during the rest of the year (225 days), at about 230 t/day [1]. Out of a total of 206 tanneries in Bangladesh, 192 of them were located in the Hazaribagh district of Dhaka city. An extensive project was taken by the government to shift the whole tannery industry to Savar tannery estate with sustainable management options comprising with Central Effluent Treatment Plant (CETP) with Sludge Power Generation System (SPGS) for saving Dhaka city from pollution. Presently 101 tanneries among them have been shifted to Savar tannery estate and in operation as well.

3.2. Study Area: Savar Tannery Estate

Figure 1: Study Area –Savar Tannery Estate

Savar tannery estate is situated at 20km (23°46′44.05″N, 90°14′39.34″E) away from Dhaka city beside the Dhaleswari river covering 200 acres of land area. According to the master plan, 144 acres (72%) of the land is to

be developed as industrial plots. The balance, 56 acres (28%), will be utilized for infrastructure for the estate that includes a CETP, disposal yard, administrative building, drainage, electricity sub-station and others.

3.3. Present Status of Savar Tannery Estate

Savar tannery estate is a newly developed industrial zone for the leather sector only. It is situated beside the Dhaleswari river. To materialize the plan of making a safe and environment-friendly industrial zone, govt. decided to shift the whole tanning industry from Hazaribagh to new tannery estate. 101 tanneries are now running their operation including a CETP, disposal yard, administrative building, drainage, electricity sub-station and others. But the fact is that proper management option for solid waste has not been observed there till now though the master plan consists highly sophisticated SPGS system to manage solid waste. From field observation, it can be concluded that presently crude dumping of wastes making the zone polluted as before which is unexpected and harmful for the environment as well. The extracted sludge from CETP is being stored on the side of the road and in open land. Some scenarios of Savar tannery estate are shown in Figure 2.

(a) (b)

(c) (d)

Figure 2: (a) Construction phase running; (b) CETP unit in operation; (c) Dhaleswari river beside the estate; (d) Solid wastes dumped in open land in Savar tannery estate

3.4. Solid Waste Types and Their Present Management Practices

The main sources of solid waste in tanneries originate from trimming and fleshing of raw hides and skins as well as splitting and shaving of tanned hides and skin material. However, many of these wastes may be classified as by-products because they may be sold as raw materials to other industry sectors. In different stages of leather processing, various types of wastes are generated. The name of the solid wastes generated in various steps and their present management practices are discussed in Table 1.

Various pictures of the present condition of waste management are included in figure 4 below. The ancient practices are now being stopped by govt. for the sake of the environment. As sustainable management options have not been developed yet owners are dumping their wastes mostly and ancient practices are being done secretly.

3.5. Tannery Solid Waste

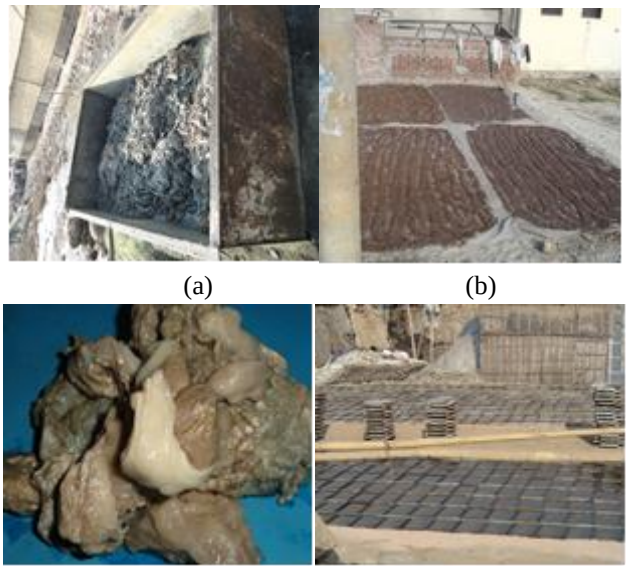
Leather processing is characterized by large amounts of solid and liquid waste. Pretanning processes are those in which most of the solid waste is produced. Tannery industry produces a large amount of biodegradable waste which is fleshing, composed mostly of lipids and fats. They originate from the process of animal skin preparation for the tanning process. In this process, all adherent flesh, fatty tissue, rough edges and impurities are removed from animal skin. In order to examine the appropriate technology for the management of solid

waste from the tanning industry, it is necessary to assess the overall tanning process and the characteristics of the waste. By examining the present management practices and the characteristics of waste, it is observed that one of the vital solid wastes fractions of the tannery industry is fleshing. This part of waste needs proper attention to manage. Fleshings are shown in figure 3(c). Solid waste from various stages of the tanning process and their usual management practices are shown in Figure 3.

Table 1: Solid waste from various stages of the tanning process and their conventional management practices

Types of solid waste	Characteristics	Management (Current practices)	Generation rate (Kg/ton)
Dusted Salt	Contaminated with blood, hair, dirt, and bacteria. Salt from solar pan.	Partly reused in curing and the rest is indiscriminately dumped in undeveloped lands near the tanneries.	300
Raw Trimmings	The skins are trimmed (especially at hair, legs, belly, neck, and tail parts) in order to give them a smooth shape.	The trimmings are usually used to produce glue/gelatin.	140
Fleshing	Removed subcutaneous material. This is the flesh material of limed skins.	A portion of it is sold to soap and poultry feed makers. Most of the portion is dumped here and there.	180
Wet Trimming/ Wet Shaving	After chrome tanning, skins or split hides are shaved to the proper thickness. This operation produces solid waste containing chrome.	Secondary users including poultry feed makers, usually collect these shaving from the tanners. For govt. allegation this part is also dumped.	190
Dry Trimmings / Dry Shaving/ Buffing Dust	Abrasion of the surfaces of the leather to reduce nap or grain defects.	Secondary users, including poultry feed makers, collect cuttings and dry trimmings and buffing dust of the leather from the tanneries	100
Assorted Refuse		This is normally sold separately (in bulk) in the retail market.	Not known
Different Sludge's from CETP	Dried part of primary and secondary sludge.	Dumped in open land, nearby riverside.	125

Source: Field observation, discussion with local people, leather technicians, workers. Wastes generation rate was obtained from the processing of 1 ton of raw hides (Alamgir et.al. 2017).



(a) (b)

(c) (d)

Figure 3: (a) Fleshing burning for recovering fat; (b) Chrome shaving dust is converted to poultry feed; (c) Fleshing; (d) Preparing glue from raw trimming.

3.6. Primary and Secondary Sludge

Sludge mainly comes from the wastewater treatment plant as semi-solid residual material. There are mainly two types of sludge produced from the treatment processes one is primary sludge and another is secondary sludge (Figure 4). Primary sludge mainly contains suspended solids and microorganisms which settle down by gravitational sedimentation. On the other hand, secondary sludge contains settled biomass due to the consumption of organic matter by a residual microorganism. The microorganisms feed on the biodegradable material of the wastewater in the aeration tank, then flow into secondary clarifier where biomass is settled out and removed as secondary sludge. Primary sludge contains more energy than secondary sludge as the energy content of primary sludge is not consumed whereas secondary sludge is only inert biomass [5]. The CETP of the leather industry contains a huge quantity of sludge which also demands proper attention for disposal.

Figure 4: Primary clarifier and secondary clarifier of CETP, Savar tannery estate

3.7. Characteristics of Wastes

The literature review shows that waste to energy is the most appropriate option to manage waste worldwide and the tannery wastes are mostly biodegradable. So, the study emphasizes on the biodegradation characteristics of waste. Table 2 representing the characteristics of the wastes shows that fleshing contains about 81% of volatile solid and 44% of protein content. The C/N ratio of fleshing is 2.64, which is quite low for optimum biogas generation [4]. The pH of the fleshing is extremely high for its liming effect and that is 10.99. The primary sludge can also act as a source of various microorganisms required for anaerobic digestion [2] though the C/N ratio of primary (0.89) and secondary sludge (0.87) are very low.

Table 2: Characteristics of wastes

Constituents	Limed Fleshing	Primary Sludge	Secondary Sludge
pH	10.99	7.7	7.2
TS (%)	13.38	4.58	5.56
VS (%)	81.43	35.57	30.54
Protein (%)	44.16	27.87	22.12
Moisture Content (%)	86.62	93.22	94.52
COD (mg/l)	-	-	-
Calorific Value (Kcal/kg)	4323.06	4118.03	3224.5
C/N Ratio	2.64	0.89	0.87

4. Discussion

To save the environment as well as the leather industry it is high time to think about the technological measures to combat environmental challenges from leather processing activities. Hence, the solid waste management system of Savar tannery estate requires special attention to reduce environmental degradation. Some recommendations are made here from literature study which can be helpful to make a further decision on tannery waste management:

- For developing a proper solid waste management system for the tannery waste, it is obvious to manage each fraction of the waste in a cost-effective and environment-friendly way.
- The study shows that a major portion of the solid wastes from the leather industry is fleshing which contains mainly fat, protein and residual chemicals such as lime and sulfide used in the unhairing

process of beam house operation [2]. Gaseous efficiency of fat is estimated to be higher than those of carbohydrates and proteins, therefore, lipid-rich waste can be regarded as a large potential of renewable energy sources [6].

- It is important to evaluate appropriate techniques for recovering energy from waste. Anaerobic digestion is considered as one of the best treatment methods for the organic fraction of the segregated waste. It is a microbiological process for the decomposition of organic matter, in the absence of oxygen, which has two main end products: biogas and digestate [7]. It occupies very little land and requires low or no energy in operation [8]. According to the findings of previous research, tannery waste is used in different means for anaerobic digestion. Biogas generation can be accomplished by the co-digestion of tannery solid waste [9]. If only tannery sludge is used, the gas production rate is low and therefore, using tannery solid waste with tannery sludge is recommended [10]. There is a wide variety of solid waste management options available around the world. According to the geo-socio-economic condition of Bangladesh, it is necessary to establish such a management option for solid waste which will be not only cost-effective but also sustainable and environment friendly [1].

5. Conclusions

The objectives of the study were to investigate the present solid waste management status of the Savar tannery estate and to provide some recommendations on choosing a suitable management option for the tannery solid waste. The present condition of the tannery estate was evaluated by field survey and from critical observation. It was observed that no proper management technology was found there for a large amount of tannery solid waste like fleshing, primary sludge and secondary sludge. Crude dumping of this waste is not only unaesthetic but also unsafe for the environment. Laboratory experiments have been showed that tannery wastes contain a good percentage of volatile solid which is amenable for biodegradation. The study has been shown some indications of the potentiality of the gas generation of tannery waste. Extensive research should be done to adopt a proper waste management system to manage tannery waste in order to save the leather industry and the environment of Bangladesh.

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